

**Practical Guide**

**Biology**  
for 'O' Level  
**Practical  
Assessment**



**Sharon Kwok**



**HODDER  
EDUCATION**

AN HACHETTE SINGAPORE COMPANY

# Contents

	<b>Preface</b>	iii
<b>THEME 1</b>	<b>Movement of substances</b>	2
	Experiment 1.1	10
	Experiment 1.2	16
<b>THEME 2</b>	<b>Biological molecules</b>	19
	Experiment 2.1 	27
	Experiment 2.2	32
<b>THEME 3</b>	<b>Photosynthesis</b>	38
	Experiment 3.1 	43
	Experiment 3.2	49
<b>THEME 4</b>	<b>Respiration</b>	53
	Experiment 4.1	57
	Experiment 4.2	62
<b>THEME 5</b>	<b>Reproduction in plants</b>	65
	Experiment 5.1	69
	Experiment 5.2	72
	<b>Practical checklists</b>	75
	<b>Formulas and glossary</b>	76
	<b>Experiment sample results</b>	78
	<b>Materials preparation list</b>	80
	<b>Answers</b>	87
	<b>Index</b>	139
	<b>Insert</b>	141

# Movement of substances

## Diffusion

The net (overall) movement of molecules from a region of higher concentration to a region of lower concentration, down a concentration gradient.

- Any type of solute molecule.
- Partially permeable membrane may or may not be present.

## Factors affecting the rate of diffusion

Increasing this factor	Effect on the rate of diffusion
Size of molecule	Decrease
Temperature	Increase
Concentration gradient	Increase
Surface area to volume ratio	Increase

## Osmosis

The net movement of water molecules from a region of higher water potential to a region of lower water potential, down a water potential gradient, across a partially permeable membrane.

- Highest water potential: pure water (e.g. distilled water)
- Lower water potential: higher solute concentration (e.g. with dissolved sodium chloride, glucose, etc.)

Type of solution	Solute concentration	Water potential
Concentrated	High	Low
Dilute	Low	High

## Partially permeable membrane

- Allows some substances to pass through, but not other substances.
- Usually smaller molecules can pass through more easily than larger molecules.
- Includes: cell membrane of living cell, artificial membranes such as Visking tubing, dialysis tubing and cellophane tubing, etc.

## Effect of osmosis on cells

Type of solution	Movement of water molecules by osmosis	Descriptions of cells	
		Plant cell	Animal cell
Dilute	Enter cell	Turgid	Burst
Concentrated	Exits cell	Flaccid, eventually plasmolysed if water continues to move out	Crenated

## Active transport

Energy is used to transport substances across a biological membrane against a concentration gradient.

- Only in living cells.
- Not in artificial membranes (Visking tubing, dialysis tubing, cellophane tubing).

## Experiments on movement of substances

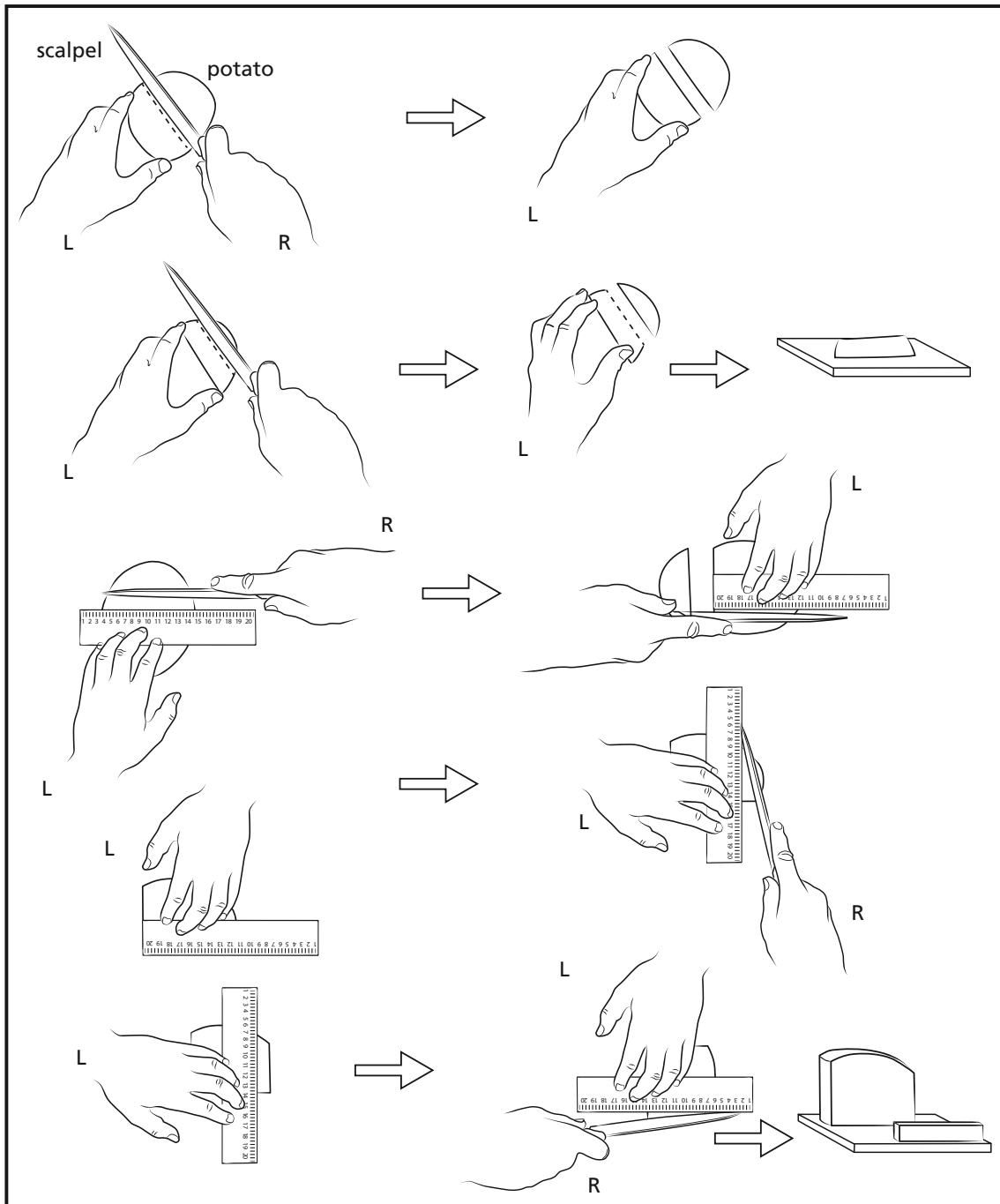
Experiments on diffusion may involve cells or other non-cellular materials.

Experiments on osmosis may involve plant cells, plant tissues, Visking tubing, cellophane tubing or dialysis tubing.

Experiments on active transport will usually not be done.

# Practical tips

## Cutting potato into blocks or strips



1. Use your left hand to hold one side of the potato firmly on the white tile.
2. Hold the knife or scalpel in the right hand.
3. Cut one side of the potato.
4. Use your left hand to hold the freshly cut flat side of the potato firmly.
5. Cut the right side of the potato parallel to the left side so that there are two parallel flat sides.
6. Place a flat side of the potato on the white tile.
7. Cut the left end of the potato.
8. Place the ruler perpendicular to the left end.
9. Cut the potato along the ruler edge to form the bottom edge of the potato strip.
10. Place the ruler along the bottom edge.
11. Using the ruler, measure the length of the potato strip needed and make a small mark on the potato.
12. Place the ruler at your mark, perpendicular to the bottom edge of the potato strip.
13. Cut the potato along the ruler edge, starting from your mark, to form the right end of the potato. The right end of the potato strip should be parallel to the left end.
14. Place the ruler along the right end.
15. Using the ruler, measure the width of potato strip needed and make a small mark on the potato.
16. Place the ruler at your mark, perpendicular to the right edge of the potato strip.
17. Cut the potato along the ruler edge to form the potato strip.
18. Repeat steps 14 to 17 to cut more potato strips.
19. Cut to adjust the length, width or height of the potato blocks or strips if necessary.
20. Ask for another potato and repeat the cutting steps if you do not have enough potato strips.

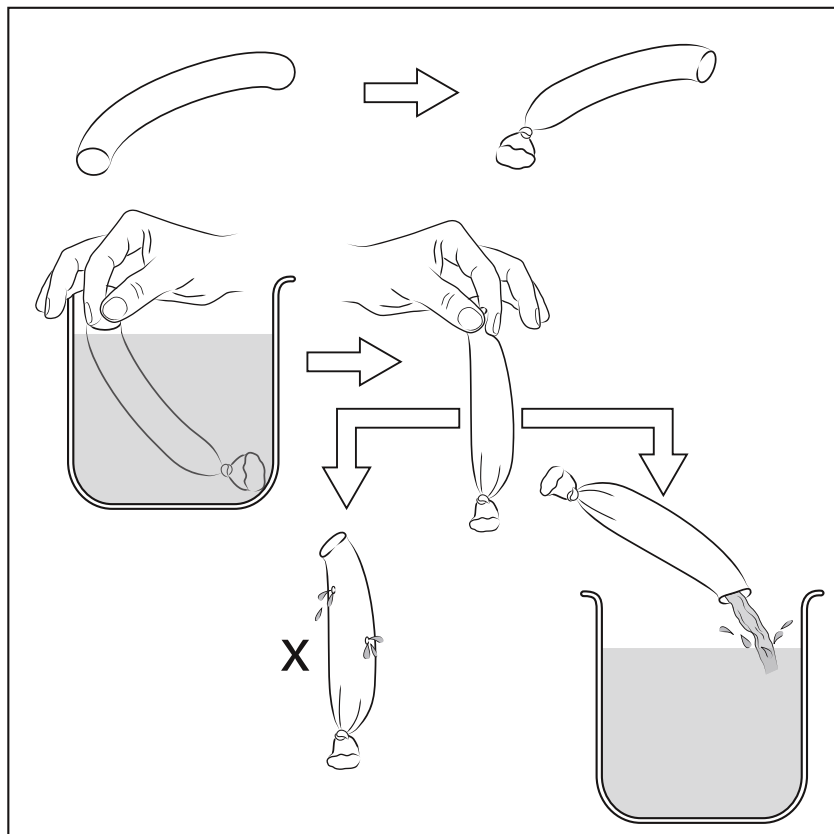
**\*Note:** *If you are left-handed, use your left hand to hold the knife or scalpel and your right hand to hold the potato and ruler instead.*



#### Safety Notes

- Place your left hand on top of the ruler, with your fingers away from the ruler edge.
- Press the ruler firmly downwards on to the potato to prevent the ruler from moving when cutting.
- Cut the potato downwards along the ruler edge using your right hand.
- Always point the sharp knife or scalpel away from your hand and fingers.
- When not using, keep the knife or scalpel safely away from the experimental set-up.

## Visking tubing

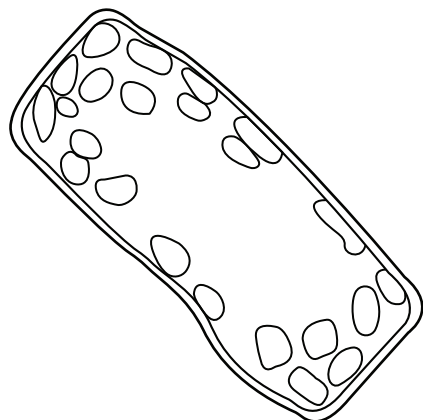
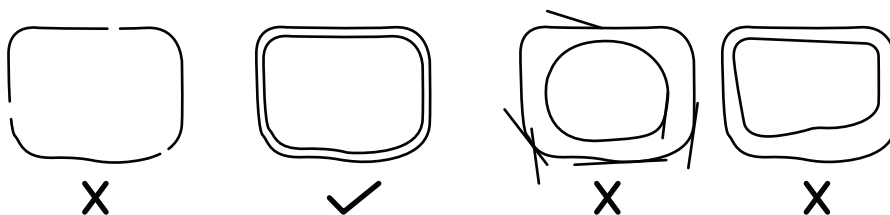


1. Tie one end of the dry Visking tubing into a knot.
2. Fill a beaker to about half-full with distilled water.
3. Place the whole Visking tubing into the water.
4. Rub the untied end of the Visking tubing between your thumb and index finger in the water until the end of the Visking tubing opens. Fill the Visking tubing with water.
5. Lift the Visking tubing out of the beaker and check for leakage.
6. If the water level in the Visking tubing changes, there is a leak. Repeat steps 1 to 5 with a new piece of Visking tubing.
7. If the water level in the Visking tubing remains the same, there is no leak and the Visking tubing is ready to be used for the experiment. Pour the water away and fill the Visking tubing  $\frac{3}{4}$  full with the solution stated in the experiment.

### Precautions:

- Open the Visking tubing under water. Dry Visking tubing cannot be opened easily.
- Be careful not to scratch or tear the Visking tubing with your fingernails. Fingernails should be kept short and blunt.
- Put the beaker in the sink. Prepare the Visking tubing in the sink to avoid spilling water on the bench.

## Biological drawing of cells



- Photographs, pictures or figures containing cells may be provided in the question.
- Draw all visible parts of the cells under the light microscope, which include the nucleus, chloroplasts, cell membrane and cell wall.
- Use a sharp 2B pencil. Do not draw using a pen.
- Draw with a single continuous dark pencil line. There should not be any unnecessary lines sticking out of your pencil outline.
- Erase unwanted lines completely and cleanly.
- Outlines should be in complete lines. There should be no gaps in your pencil lines.
- Do not shade or colour your drawing unless it is stated in the instructions.
- Make a large, accurate drawing that occupies more than  $\frac{1}{2}$  (preferably at least  $\frac{2}{3}$  to  $\frac{3}{4}$ ) of the space provided.
- Draw what you see, do not draw what you do not see (avoid artefacts). Do not draw a textbook/schematic diagram of the cells. Do not draw non-visible organelles of the cells, such as mitochondria.
- Ensure that the parts of the cells drawn are in proportion. For example, the cell wall should have the same thickness around the whole cell. Use your fingers or a ruler to estimate the proportions of the parts of the cells in the figure(s). You do not need to measure accurately.
- Do not label your drawing if the question does not tell you to label your diagram.
- Use a ruler and pencil to draw straight label lines. Label words should be written outside the cells, around your drawing.
- Only draw the cell(s) required by the question.



Key marking points for drawings:

- Accuracy of drawing, avoid artefacts (unnatural man-made item).
- Appropriate size and proportion of drawing.
- Good quality of lines drawn.
- Labelling of all required parts (if required).
- All relevant or required parts drawn.
- Include a title (if required).

## Magnification

$$\text{Magnification} = \frac{\text{image size (drawing)}}{\text{actual size (specimen)}}$$

You need to measure the length, width, height or diameter of your drawing and your cell(s).

Drawing size	Specimen size	Magnification
Larger	Smaller	Greater than 1
Smaller	Larger	Smaller than 1

## Planning

- Identify the independent variable (the variable that is changed or varied during the experiment) from the aim.
- Suggest a minimum of five different values of the independent variable with regular intervals: e.g. 20°C, 30°C, 40°C, 50°C, 60°C.
- Identify the dependent variable (the variable to measure under investigation) from the aim.
- Suggest how to measure the dependent variable: e.g. measure the time taken for the colour to change, count the number of bubbles, measure the volume of gas, measure the mass, etc.
- Identify at least two fixed or controlled variables that can affect the results of the experiment to be measured and kept constant.
- Draw a labelled diagram of the set-up needed or describe any modifications to the original set-up that should be made.
- Write down the name of the apparatus used to make each measurement. Apparatus used in the main experiment may be used.
- Steps and details depend on the aim of the experiment. Steps from the main experiment may be used with modifications.
- State the safety precautions.
- Repeat the experiment and calculate the average results for reliability.
- State the expected results if the question requires you to do so.

### Key marking points for planning:

- Appropriate variables identified: independent, dependent and fixed or controlled variables.
- Drawing or description of the set-up needed.
- Steps of the experiment.
- Expected results (if required).

### *Sample planning questions*

1. Design an experiment to investigate the effect of temperature on the rate of diffusion in beetroot.
2. Design an investigation to test the effect of sucrose concentration on the rate of osmosis in potato cells.
3. Plan an experiment to determine the sucrose concentration of potato cells.



## Experiment 1.1

You are advised to read the whole question before you start.

You are going to investigate the effect of four different concentrations of glucose solutions on potato tissue.

### Part 1

You are provided with:

- A peeled potato.
- A pair of forceps or tweezers.
- A kitchen knife or scalpel.
- A white tile.
- A 15 cm rule.
- Four glucose solutions of different concentrations (G1 to G4).
- Four beakers.
- A stopwatch.
- A graph paper mounted on a stand.
- A retort stand.
- A piece of cork.
- A pin.
- Four pieces of clean dry filter paper or paper towels.

**Step 1** Label the four beakers G1 to G4.

**Step 2** Carefully cut five strips of potato tissue, each measuring 80 mm × 5 mm × 5 mm.

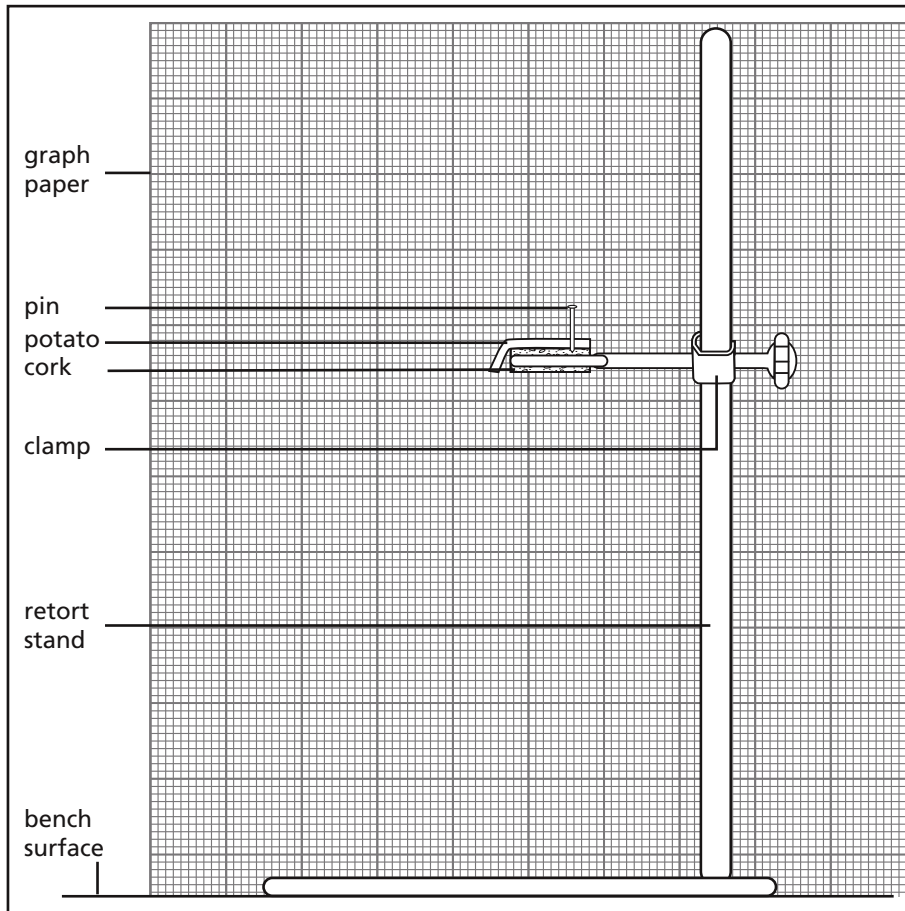
**Step 3** Place one potato strip into each beaker G1 to G4. Leave the last strip aside.

**Step 4** Pour glucose solutions G1 to G4 into the respective beakers. Ensure that the potato strips are completely covered by the glucose solutions. Start the stopwatch.

**Step 5** Clamp the piece of cork to the retort stand.

**Step 6** Insert a pin near the end of the last potato strip and attach the potato strip securely on to the cork. Ensure that the end of the potato strip is at the edge of the cork.

**Step 7** Place the mounted graph paper behind the potato strip as shown.



- Step 8** On the graph paper, mark the two ends of the potato strip. Label both points as X. Remove the potato strip.
- Step 9** After 20 minutes, remove the potato strips from G1 to G4 and dry each of them with a piece of filter paper or paper towel.
- Step 10** Repeat steps 6 to 8 for the four potato strips. Instead of X, label the points on the graph paper as G1 to G4 respectively.

- (a) Measure the vertical distance between the two points labelled X and record your result in the table below. Repeat for G1 to G4. [3]

Potato strip	Vertical distance between points/mm
X	
G1	
G2	
G3	
G4	

- (b) Describe your observations for G1 and G4. Explain your results as clearly as possible. [4]

---

---

---

---

---

---

---

---

---

---

- (c) Which glucose solution had the most similar concentration of glucose as the potato tissue? Explain your answer. [2]

---

---

---

---

(d) Arrange the four glucose solutions in the order of increasing glucose concentration. [1]

---

---

(e) Which glucose solution resulted in the firmest potato strip? [1]

---

---

(f) Which glucose solution resulted in the softest potato strip? [1]

---

---

(g) State one experimental error that could cause your results to be inaccurate. [1]

---

---

(h) Suggest how you can extend this experiment to determine the concentration of glucose in potato tissue. [4]

---

---

---

---

---

---

---

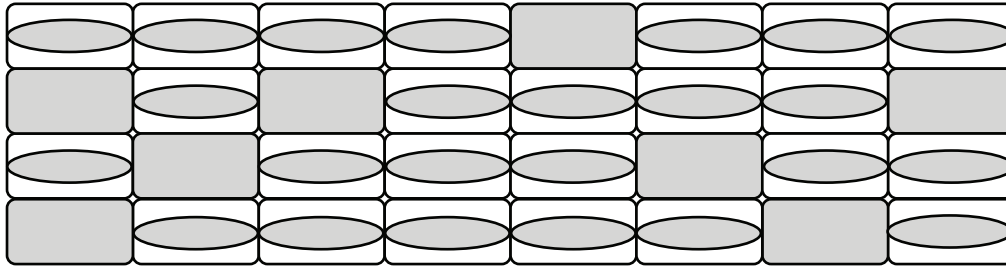
---

---

---

## Part 2

- (i) The figure below represents potato cells placed in a 0.6% glucose solution. Some of the potato cells are plasmolysed.



key



plasmolysed cell



non-plasmolysed cell

Count and record the number of plasmolysed and non-plasmolysed cells below. [1]

Plasmolysed cells = \_\_\_\_\_

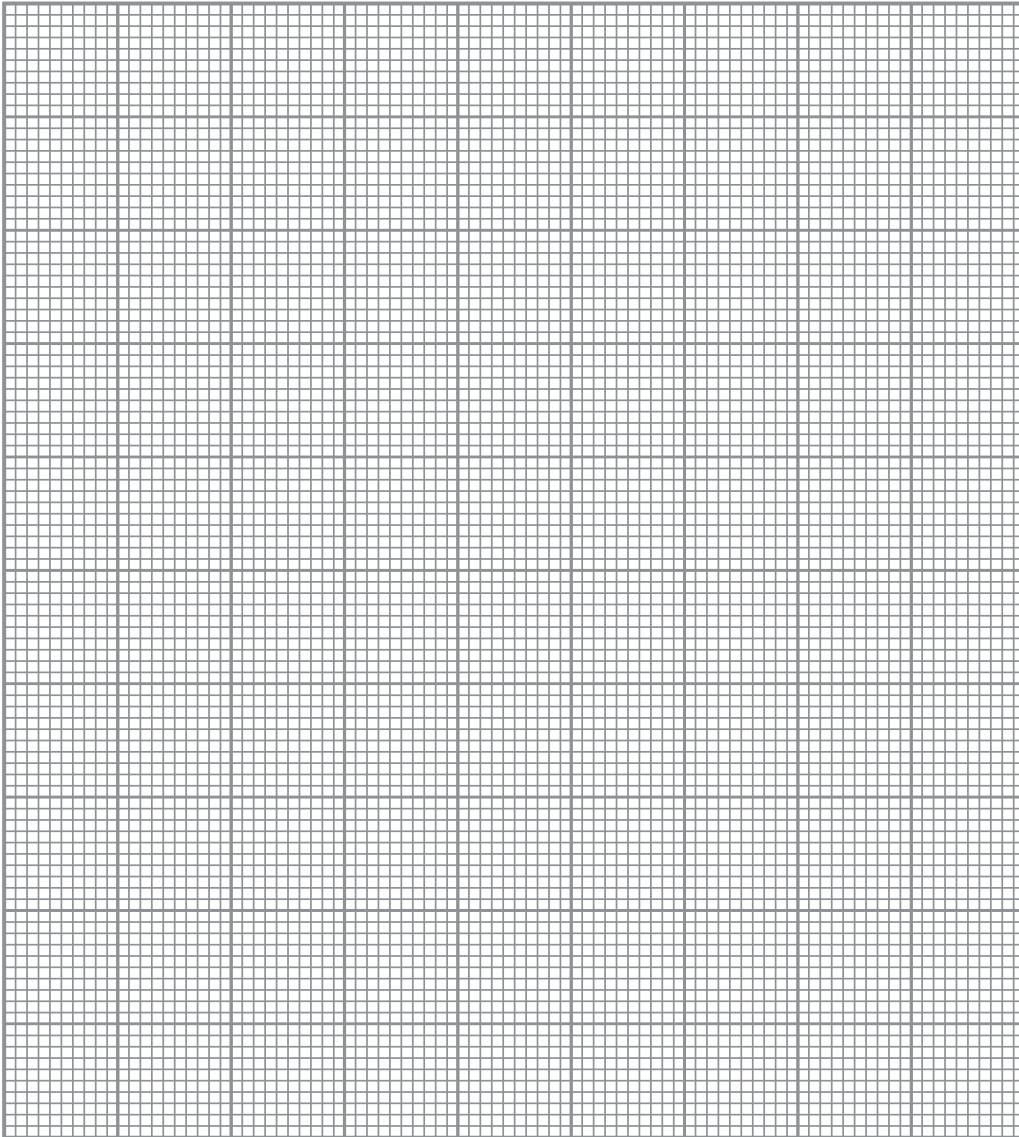
Non-plasmolysed cells = \_\_\_\_\_

- (j) Calculate the percentage of plasmolysed cells. Show your working. [1]

- (k) Complete the table below with your answer in (j).

Concentration of glucose solution/%	Percentage of plasmolysed cells/%
0.0	0
0.2	7
0.4	17
0.6	
0.8	100

Use the grid provided to plot a graph of the results in the table. Draw a line of best fit through the points. [4]



- (I) Use your graph to determine the concentration of glucose that would result in 50% of potato cells being plasmolysed. Show your working on your graph. [2]

Glucose concentration = \_\_\_\_\_

[Total: 25]



# Answers

## Experiment 1.1

You are advised to read the whole question before you start.

You are going to investigate the effect of four different concentrations of glucose solutions on potato tissue.

### Part 1

You are provided with:

- A peeled potato.
- A pair of forceps or tweezers.
- A kitchen knife or pen-knife.
- A white tile.
- A 15 cm rule.
- Four glucose solutions of different concentrations (G1 to G4).
- Four beakers.
- A stopwatch.
- A retort stand.
- A piece of cork.
- A pin.
- A graph paper mounted on a stand.
- Four pieces of clean dry filter paper or paper towels.

- Step 1** Label the four beakers G1 to G4.
- Step 2** Carefully cut five strips of potato tissue, each measuring 80 mm × 5 mm × 5 mm.
- Step 3** Place one potato strip into each beaker G1 to G4. Leave the last strip aside.
- Step 4** Pour glucose solutions G1 to G4 into the respective beakers. Ensure that the potato strips are completely covered by the glucose solutions. Start the stopwatch.
- Step 5** Clamp the piece of cork to the retort stand.
- Step 6** Insert a pin near the end of the last potato strip and attach the potato strip securely on to the cork. Ensure that the end of the potato strip is at the edge of the cork.
- Step 7** Place the mounted graph paper behind the potato strip as shown.



**Thought process:**  
Osmosis

### Note to teacher:

G1: 0% glucose (100% water),  
G2: 0.8% glucose,  
G3: 0.4% glucose,  
G4: 2% glucose.

### Skill tip

Check that the graph paper is vertically upright.

### Skill tip

Use cutting method described in summary notes.



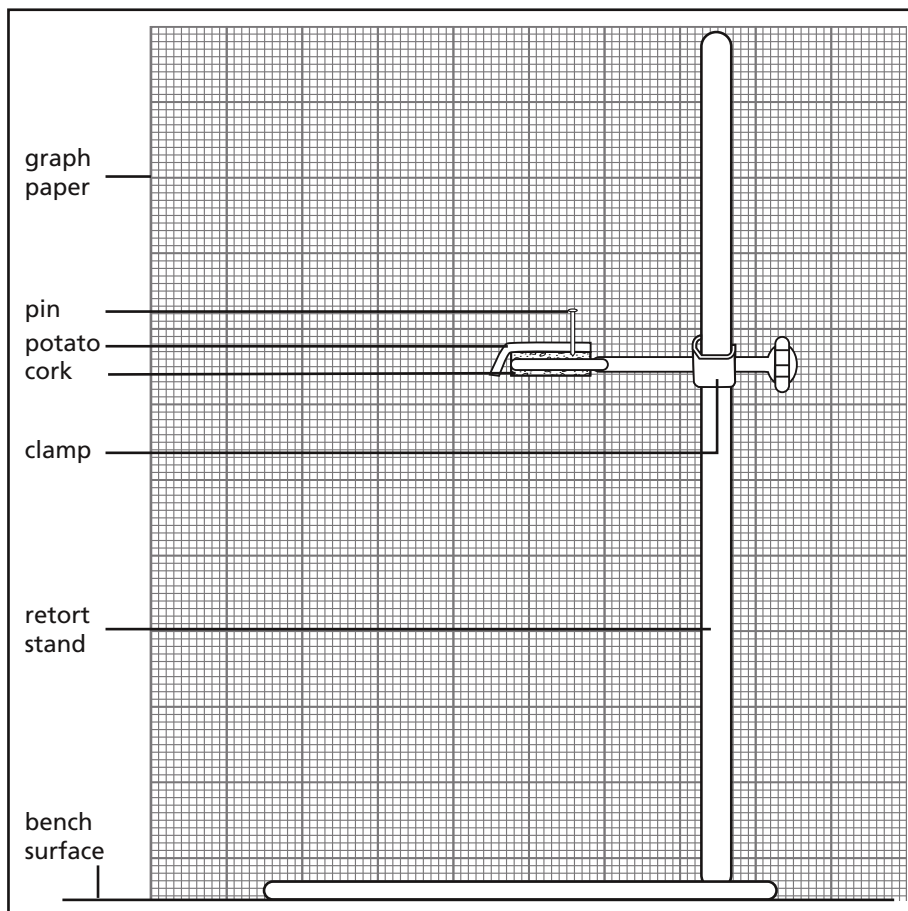
**Thought process:**

The last potato strip acts as a control for comparison of results.



**Thought process:**

Maximum surface area in contact with glucose solutions for highest rate of osmosis.



**Step 8**

On the graph paper, mark the two ends of the potato strip. Label both points as X. Remove the potato strip.

**Skill tip** ✓

Use pencil to mark the top of the 2 ends of the potato strip.

**Step 9**

After 20 minutes, remove the potato strips from G1 to G4 and dry each of them with a piece of filter paper or paper towel.

**Skill tip** ✓

Completely wrap each potato strip in a separate piece of filter paper or paper towel. Pat dry a few times until no water drips from the potato strips.

**Step 10**

Repeat steps 6 to 8 for the four potato strips. Instead of X, label the points on the graph paper as G1 to G4 respectively.

**Skill tip** ✓

You can use different parts of the graph paper to mark the points.



- (a) Measure the vertical distance between the two points labelled X and record your result in the table below. Repeat for G1 to G4. [3]

Potato strip	Vertical distance between points/mm	Range of values of vertical distance/mm
X	1	0-2
G1	0	0-2
G2	40	30-60
G3	2	2-10
G4	15	10-30

- (b) Describe your observations for G1 and G4. Explain your results as clearly as possible. [4]

Water potential of G1 is higher than potato cells/tissue.  
Solute concentration of G1 is lower than potato cells/tissue.  
G1 is a more dilute solution compared to potato cells/tissue.

Water moves from a region of higher water potential in G1 to a region of lower water potential in potato cells/tissue through the partially permeable cell membrane by osmosis.  
Potato cells become turgid.

Water potential of G4 is lower than potato cells/tissue.  
Solute concentration of G4 is higher than potato cells/tissue.  
G4 is a more concentrated solution compared to potato cells/tissue.

Water moves from a region of higher water potential in potato cells/tissue to a region of lower water potential in G4 through the partially permeable cell membrane by osmosis.  
Potato cells become flaccid/plasmolysed.

**Skill tip** ✓

Do not measure the horizontal distance (length of the potato strip). Use the graph paper to measure the vertical distance.



**Marking:**

A (accuracy) [2]: correct range of values.  
V (values) [1]: all values filled up.



**Marking:**

Any 1 point. [1]



**Marking:**

Any 1 point. [1]



**Marking:**

Any 1 point. [1]



**Marking:**

Any 1 point. [1]



**Thought process:**

Different concentrations of glucose result in different rates of osmosis. If water enters potato, potato cells become turgid. Potato strip will be firm and not sag downwards. If water exits potato, potato cells become flaccid or plasmolysed. Potato strip will be soft and sag downwards.



- (c) Which glucose solution had the most similar concentration of glucose as the potato tissue? Explain your answer. [2]

G1/ G3/ G4.

Distance between points most similar to X.

- (d) Arrange the four glucose solutions in the order of increasing glucose concentration. [1]

G1, G3, G4, G2.

- (e) Which glucose solution resulted in the firmest potato strip? [1]

G1.

- (f) Which glucose solution resulted in the softest potato strip? [1]

G2.

- (g) State one experimental error that could cause your results to be inaccurate. [1]

Constant evaporation of water from the sugar solutions would increase the concentration of the solutions over time. The length of the potato strips would be longer than expected.



**Marking:**

Accept ecf based on the result table.



**Marking:**

Accept ecf based on the result table.



**Marking:**

Accept ecf based on the result table.



**Marking:**

Accept ecf based on the result table.



**Marking:**

Any 1 point. [1]



**Thought process:** Which steps in the method may give errors? Which apparatus may give inaccurate measurement? Did you encounter any difficulties while doing the experiment?



- (h) Suggest how you can extend this experiment to determine the concentration of glucose in potato tissue. [4]

Independent variable: glucose concentration.

Dependent variable: vertical distance between points.

Controlled variables.

- Starting length of potato strips (80 mm).
- Width and height of potato strips (5 mm).
- Time taken (20 minutes).
- Position on cork (edge of potato strip at edge of cork).

**Step 1** Repeat the experiment with 5–6 solutions of different glucose concentrations (0.0%, 0.2%, 0.4%, 0.6%, 0.8%, 1.0%).

**Step 2** Measure and record the distance between points.

**Step 3** Calculate the change in distance from X (change in distance = distance between points – X).

**Step 4** Plot a graph of change in distance from X/mm against glucose concentration/%.

**Step 5** The x-intercept (change in distance from X = 0 mm) is the glucose concentration of the potato tissue.



**Thought process:**  
Which steps of the experiment should be changed?



**Thought process:**  
Choose variables that can affect the vertical distance.



**Marking:**  
Variables [1]: independent, dependent, at least two controlled  
Steps. [1]  
Graph to plot. [1]  
How to find glucose concentration of potato tissue. [1]

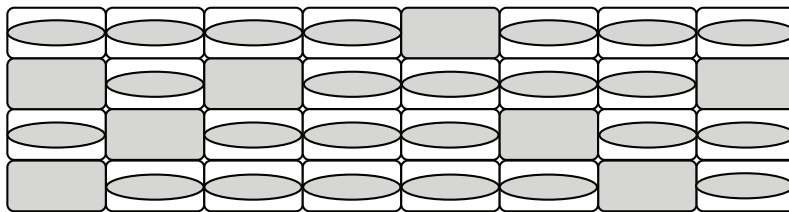


**Thought process:**  
When the glucose concentration is equal to potato cells, the rate of osmosis is zero. The potato strip will be similar to or same as the control.

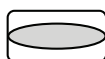


## Part 2

- (i) The figure below represents potato cells placed in a 0.6% glucose solution. Some of the potato cells are plasmolysed.



key



plasmolysed cell



non-plasmolysed cell

Count and record the number of plasmolysed and non-plasmolysed cells below. [1]

Plasmolysed cells =  $\frac{24}{32}$   
 Non-plasmolysed cells =  $\frac{8}{32}$

- (j) Calculate the percentage of plasmolysed cells. Show your working. [1]

Percentage of plasmolysed cells =  $\frac{24}{32} \times 100\% = 75\%$

- (k) Complete the table below with your answer in (j).

Concentration of glucose solution solution/%	Percentage of plasmolysed cells cells/%
0.0	0
0.2	7
0.4	17
0.6	75
0.8	100

Use the grid provided to plot a graph of the results in the table. Draw a line of best fit through the points. [4]

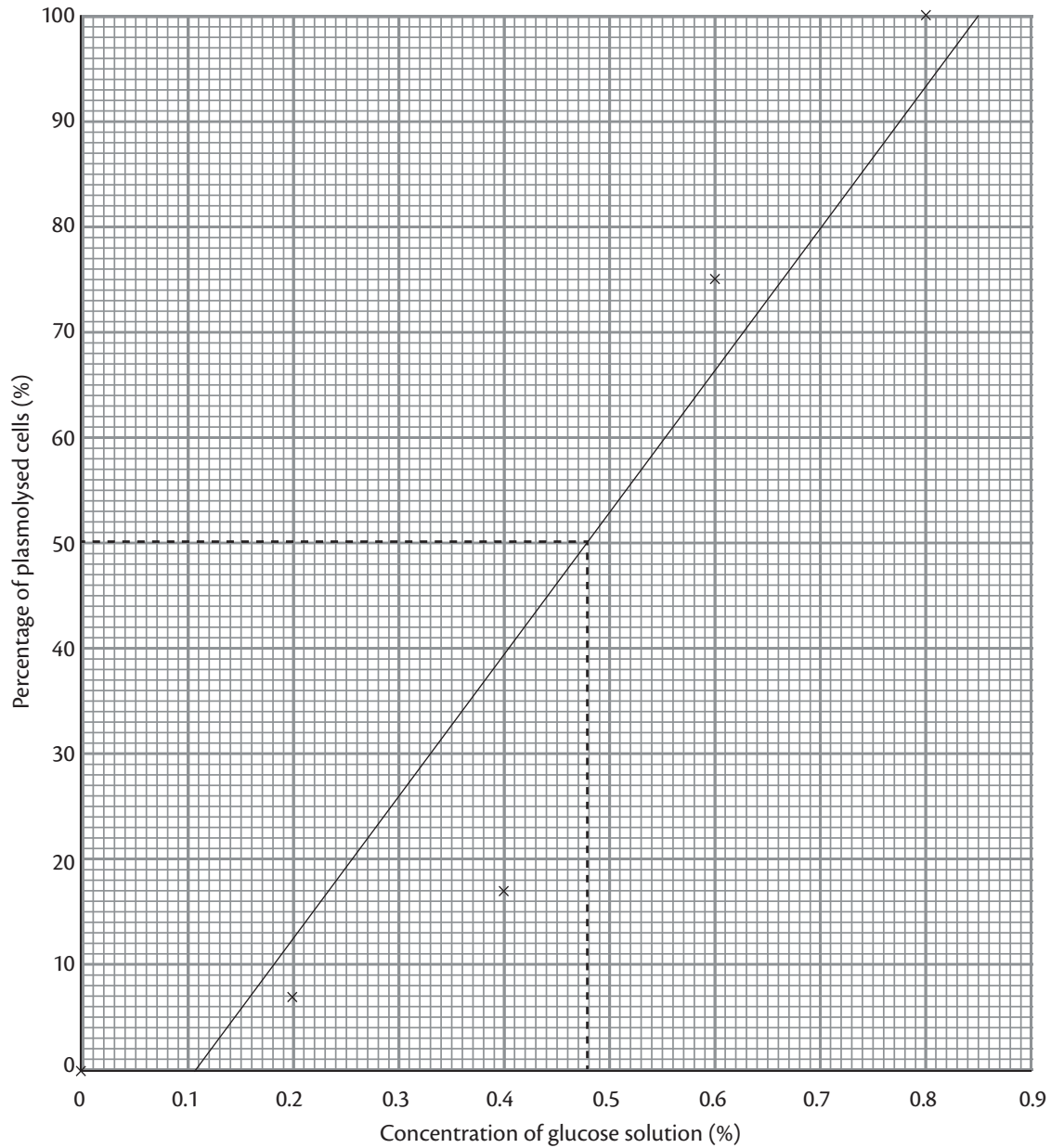


**Marking:**  
 No working. [0]



**Marking:**  
 S (scale) [1]: multiples of 2, 5 or 10, occupy more than  $\frac{2}{3}$  of the grid.  
 L (line) [1]: best fit line.  
 A (axis) [1]: correctly labelled with relevant units.  
 P (plot) [1]: points accurately plotted to half of smallest square.





- (i) Use your graph to determine the concentration of glucose that would result in 50% of potato cells being plasmolysed. Show your working on your graph. [2]

Glucose concentration = 0.48% (0.45% – 0.55%).

[Total: 25]



**Marking:**  
Working lines on graph. [1]



**Marking:**  
Correct value. [1]



**Skill tip**

Draw a horizontal line from 50% to the line of best fit and then draw a vertical line down to find the glucose concentration.